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DOCUMENT-IDENTIFIER: US 20020085217 A1
TITLE: Image processing apparatus and image processing system

Abstract Paragraph:
An image processing apparatus prepares dot cluster within block by pixel value shift to determine phase quantity every pixel value block at the time of constituting stripe pattern or texture of dots by set of dot clusters within respective blocks to control value of pixel shifted from respective pixels within block to shifted pixel designated within block in accordance with phase quantity thereof. Thus, it is possible to control position within block of dot cluster within corresponding block by level smaller than pixel size. In addition, an image processing system includes at least an image reading unit in addition to such an image processing apparatus and preferably comprises an image forming unit to thereby obtain high picture quality and stable image.

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Summary of Invention Paragraph:
[0001] This invention relates to an image processing apparatus and an image processing system adapted for shifting pixel value between pixels to constitute image texture.

Summary of Invention Paragraph:
[0005] The example where modulation frequency in the stripe pattern system is further lowered is shown in FIG. 20. In this case, ink portions 160 existing in the main scanning direction are moved between pixels 150 so that dots are connected. In this example, with three pixels being as unit, left and right ink portions are concentrated in the state where central pixel is caused to be center. The method of FIG. 20 is more popular than the method of FIG. 19. This also results from the fact that width per one dot is 42 .mu.m at 600 dpi from the requirement of realization of high picture quality, whereas laser beam diameter is about 70 .mu.m, so processing of one pixel unit is actually impossible.

Summary of Invention Paragraph:
[0007] On the other hand, in the case of carrying out color recording, color recording is conducted in the state where plates (printing blocks) of four colors of CMYK having such stripe pattern structure are overlapped. When stripe patterns of respective plates are exactly the same, interference takes place between stripe patterns so that Moire fringes occur. In order to prevent such interference, it is effective to employ a method of varying, every plates, angle or phase of stripe pattern to allow frequency of the interference fringes to be unnoticeable high frequency.

Summary of Invention Paragraph:
[0008] The method shown in FIGS. 22A and 22B is proposed in the Japanese Patent Application Laid Open No. 230163/1987 as an example of such a method, wherein phases of reference signal 210 of the first line shown in FIG. 22A and reference signal 230 of the second line shown in FIG. 22B are shifted every line.

Summary of Invention Paragraph:
[0010] Furthermore, at the time of preparing stripe patterns of different angles for every plates of respective colors in color recording, plural periodical electric signals having various phases corresponding to angles must be prepared, so the circuit scale is further enlarged.

Summary of Invention Paragraph:
[0011] Furthermore, since such periodical electric signal is analog signal, anti-noise tolerance is weak (low). In the case of color recording, it is also difficult to adjust, with good accuracy, phase differences between plural periodical electric signals, resulting in the problem that smooth stripe pattern having angle cannot be generated. In addition, in dependency upon picture signal, there take place gaps 240 between stripe patterns as shown in FIG. 23, and dot modulation frequency in the main scanning direction is caused to be rather high. Thus, stable recording cannot be disadvantageously carried out.

Summary of Invention Paragraph:
[0013] As a method of solving gap of such picture signal, there has been proposed a technology in which picture image is divided into blocks 310 as shown in FIG. 24 to shift pixel 150 to shifted pixel 320 in accordance with pixel position within the block 310 to form cluster of dots within the blocks to connect clusters of dots of the respective blocks to generate stripe pattern (Japanese Patent Application Laid Open No. 41473/1999). With this method, however, since pixel is shifted only by information of pixel position irrespective of pixel value, phase ph can be controlled only in one pixel units as shown in FIG. 25. As a result, there is the problem that it is impossible to freely generate arbitrary screen angle.

Summary of Invention Paragraph:
[0015] In view of the above, there is also devised a technology in which, with respect to the highlight portion, as shown in FIG. 27, blocks of units larger than block unit constituting the stripe pattern are constituted from plural pixels existing in the main scanning direction to collect pixel values within respective blocks into one shifted pixel 330 to prepare cluster of dots, and to shift that dot cluster position every line to thereby carry out recording by pattern like dot (Japanese Patent Application Laid Open No. 205603/1999). With this method, however, since dots are collected at one portion, dots can be formed only at the central portions of pixels. As a result, the degree of freedom of phase of dots within pixels in the main scanning direction is low. Therefore, there is no problem in the case of screen angle 340 in which gradient is 1/N (N=3 in FIG. 27) as shown in FIG. 27. However, in the case of screen angle 350 except for 1/N such that screen angle gradient is 3/6 as shown in FIG. 28, intervals of dots become thin, giving feeling of noise to an observer.

Summary of Invention Paragraph:
[0021] an intrablock pixel position judging section for judging pixel position within a block in which pixels constituting image are divided in units of plural pixels;

Summary of Invention Paragraph:
[0022] a shifted pixel designating section for designating shifted pixel to be shifted in accordance with the pixel position judged by the intrablock pixel position judging section;

Summary of Invention Paragraph:
[0023] a phase calculating section for determining phase quantity of intrablock dot cluster for every block; and

Summary of Invention Paragraph:
[0024] a pixel value shift section for carrying out shift from respective pixels within the block to the shifted pixel on the basis of the phase quantity determined

by the phase calculating section and, value differences of respective pixels within the block and value of the shifted pixel.

Summary of Invention Paragraph:
[0025] In the image processing apparatus according to this invention, there is employed such an approach to determine phase quantities every pixel value blocks to control, in dependency upon the phase quantities, values of pixels shifted to plural shifted pixels designated within block from respective pixels within blocks to carry out pixel value shift to prepare dot clusters within the blocks to constitute stripe pattern or texture of dots by sets thereof. Accordingly, it is possible to control position of dot cluster within the block by level smaller than pixel size. Thus, picture quality and stability can be improved.

Summary of Invention Paragraph:
[0029] an intrablock pixel position judging section for judging pixel position within a block in which pixels constituting image are divided in units of plural pixels;

Summary of Invention Paragraph:
[0030] a shifted pixel designating section for designating shifted pixel to be shifted in accordance with the pixel position judged by the intrablock pixel position judging section;

Summary of Invention Paragraph:
[0031] a phase calculating section for determining phase quantity of intrablock dot cluster for every block; and

Summary of Invention Paragraph:
[0032] a pixel value shift section for carrying out shift from respective pixels within the block to the shifted pixel on the basis of the phase quantity determined by the phase calculating section, and value differences of respective pixels within the block and value of the shifted pixel.

Brief Description of Drawings Paragraph:
[0040] FIG. 6 is a block diagram showing an example of the configuration of the pixel position judging section in FIG. 4;

Brief Description of Drawings Paragraph:
[0041] FIG. 7 is a view showing an example of the configuration of the shifted pixel designating section in FIG. 4;

Brief Description of Drawings Paragraph:
[0042] FIG. 8 is a view showing an example of the configuration of the phase calculating section in FIG. 4;

Brief Description of Drawings Paragraph:
[0043] FIG. 9 is a view showing an example of the configuration of the pixel value shift section in FIG. 4;

Brief Description of Drawings Paragraph:
[0044] FIG. 10 is a view showing an example of the configuration of the pixel value shift section in FIG. 4;

Brief Description of Drawings Paragraph:
[0048] FIG. 14 is a table collectively showing pixel shift operation of operation circuit used in this invention;

Brief Description of Drawings Paragraph:
[0051] FIG. 17 is a Table collectively showing conventional pixel shift operation;

Brief Description of Drawings Paragraph:
[0056] FIGS. 22A and 22B are schematically views showing a method of giving phase difference to take screen angle at stripe pattern;

Brief Description of Drawings Paragraph:
[0058] FIG. 24 is a view showing a conventional method of generating stripe pattern by pixel value shift;

Brief Description of Drawings Paragraph:
[0059] FIG. 25 is a view showing the problem of the conventional method of generating stripe pattern by pixel value shift;

Detail Description Paragraph:
[0104] This gradation processing section 135 includes an intrablock pixel position judging section 410, a shifted pixel designating section 420, a phase calculating section 430, a pixel value shift section 440, and a recording device drive pulse generating section 450. Respective components will be described below in order.

Detail Description Paragraph:
[0106] The shifted pixel designating section 420 detects shifted pixel within the block from the intrablock main scanning direction coordinate 412 and intrablock sub scanning direction coordinate 414 to generate a shift pixel designation signal 422.

Detail Description Paragraph:
[0107] The phase calcualting section 430 generates phase quantity 432 indicating magnitude of dot cluster shift phase within each block from the intrablock main scanning direction coordinate 412 and the intrablock sub scanning direction coordinate 414.

Detail Description Paragraph:
[0108] The pixel value shift section 440 inputs intrablock main scanning direction coordinate 412, intrablock sub scanning direction coordinate 414, shift pixel designation signal 422, phase quantity 432 and processing pixel input value data 424 to calculate output value 442 of shifted pixel to be processed and reference position signal 444. It is to be noted that in the case where the preceding stage is Y converting section, processing pixel input value data 424 is data after undergone passing through quantizing section (not shown).

Detail Description Paragraph:
[0111] FIGS. 5A and 5B are views showing the relationship with respect to reference position signal 444 of recording device drive signal 452 in the recording device drive pulse generating section 450. FIG. 5A shows the case of left reference where image density signal is caused to be in correspondence with start of scanning time with respect to scanning time corresponding to one pixel, and FIG. 5B shows the case of right reference where image density signal is caused to be in correspondence with end of scanning time. By suitably setting reference position signal 444 generated on the basis of phase quantity 432, it is possible to generate recording device drive signal 452 at either one of these reference positions.

Detail Description Paragraph:
[0116] FIG. 7 shows the configuration of the shifted pixel designating section 420. This shifted pixel designating section 420 is comprised of look-up table LUT 421, and serves to input coordinate x412 of the main scanning direction and coordinate y414 of the sub scanning direction to generate shifted pixel designation signal 422.

Detail Description Paragraph:
[0117] FIG. 8 shows the configuration of the phase calculating section 430. This phase calculating section 430 is comprised of look-up table LUT 431, and serves to

input coordinate x412 of the main scanning direction and coordinate y414 of the sub scanning direction to output phase quantity 432.

Detail Description Paragraph:
[0118] FIG. 9 is a block diagram showing the configuration of the pixel value shift section 440. This pixel value shift section 440 includes a shift operation/reference position selecting section 4402, a pixel value buffer section 4404 and a shift operation section 4406.

Detail Description Paragraph:
[0120] The shift operation section 4406 inputs shift operation select signal 446, peripheral pixel data 448 obtained by buffering processing pixel input value data 424 at the pixel value buffer 4404, shifted pixel designation signal 422 outputted from the shifted pixel designating section 420 and phase quantity 432 outputted from the phase calculating section 430 to output output value 442 of processing pixel which is the result that shift operation has been made.

Detail Description Paragraph:
[0127] Further, at the right pixel C, recording is not carried out because pixel value D.sub.C is delivered to the central pixel B. When pixel value D.sub.B of the central pixel B has pulse width close to that of full dots so that DC cannot be completely shifted, there is the case where right pixel C is also recorded., At this time, the reference position is set at the left side. The operation processing to add pixel density signal subject to shift operation to pixel value adjacent at the left in the right pixel C in a manner stated above is called GIVEF.

Detail Description Paragraph:
[0128] Such processing are carried out with respect to three pixels arranged in the main scanning direction as shown in FIG. 24 to further shift phases of respective operations every sub scanning lines. Thus, stripe pattern having screen angle as shown in FIG. 28 can be generated. However, as previously described, with this method, there is the problem that it is impossible to generate smooth stripe pattern having screen angle.

Detail Description Paragraph:
[0129] For this reason, in the image processing apparatus according to this invention, processing in which pixel of shift destination is caused to be 2 pixels is carried out as shown in FIGS. 13A and 13B. Namely, in accordance with this processing, pixel value of right pixel C is shifted with respect to two pixels of left pixel A and central pixel B. In more detail, in the stripe pattern screen processing of three pixel modulation, processing is carried out in three pixel units arranged in the main scanning direction, and right pixel A and central pixel B are automatically caused to be shift pixels. For this reason, operation processing selection such as THRU, etc. is caused to also double as shift pixel designation, and shift pixel designation signal 422 from the shifted pixel designation section 420 is not utilized. However, at the time of collecting many pixel values to constitute dot pattern as shown in FIG. 28, shift pixel designation signal 422 is required.

Detail Description Paragraph:
[0130] FIG. 13A shows the case where left pixel A has margin with respect to full dots, and pixel value D.sub.C shifted in the right pixel C is divided into phase quantity ph and DC-ph. In this case, ph indicates positional shift quantity from position of the ideal stripe pattern. At the left pixel A, ph is shifted, and pixel value of processed pixel A becomes equal to P=D.sub.A+ph. At the central pixel B, the remaining D.sub.C-ph is shifted. Thus, pixel value of processed pixel B becomes equal to P=D.sub.B+D.sub.C-ph.

Detail Description Paragraph:
[0131] FIG. 13B shows the case where value P of shifted pixel A is above value F of

full dots. In this case, the pixel value of the left pixel A is expressed as P=F, and buf=D.sub.A+ph-F which exceeds is added to pixel B for a second time. For this reason, at the central pixel B, the final pixel quantity is expressed as D.sub.B+D.sub.C-ph+D.sub.A+ph-F=D.sub.A+D.- sub.B+D.sub.C-F.

Detail Description Paragraph:
[0132] As stated above, there is necessity of carrying out special operation in dependency upon pixel values D.sub.A, D.sub.B, DC and value of phase quantity ph, and the detail of that example is shown in Table 1 of FIG. 14.

Detail Description Paragraph:
[0133] The processing in this Table is slightly different from the processing which has been described with reference to FIGS. 13A and 13B. It is indicated that when pixel value of remarked pixel is P, pixel value adjacent at the right is Pf1, pixel value further adjacent at the right is Pf2, phase quantity is ph and full dot pixel value of one pixel is xff, pixel values 462, 464, 466 of processing pixels in respective operation circuits and write shift buffer values 472, 474, 476 given from respective operation circuits to shift value buffer section 4430 via select section 4428 are outputted in accordance with classification of the conditional column as described later. It is to be noted that it is understood that, as indicated by the conditional column of FIG. 14, even when ph has negative value, similar processing can be carried out.

Detail Description Paragraph:
[0134] As described above, by controlling shift quantity to pixels A, B of pixel value D.sub.C in dependency upon phase quantity ph, it is possible to control center of gravity position of the stripe pattern.

Detail Description Paragraph:
[0137] Then, phase quantity ph is determined in dependency upon respective block positions (N, J) with respect to pixel value D (I, J) which has been sent (step S104). This determination is carried out at the phase calculating section 430.

Detail Description Paragraph:
[0144] The operation circuits THRU 4422, TAKEF 4424, GIVEB 4426 are supplied with peripheral pixel data 448 which are data of left pixel A, central pixel B and right pixel C within a certain block. Thus, from the respective operation circuits, output values 462, 464, 466 and shift buffer values 472, 474, 476 are respectively outputted. These values are delivered to the select section 4428. Thus, either one of them is selected by shift select signal 446 outputted from the shift operation/reference position select section 4402. Output values of the respective operation circuits are outputted as output value 442 of pixel to be processed, and shift buffer value is written into shift value buffer section 4430 as select shift buffer value 478 and is read out therefrom. It is fed back to operation circuits TAKEF 4424 and GIVEB 4426 as shift buffer value 480. Such shift buffer value buf is expressed as buf=D.sub.A+ph-F shown in FIG. 13B.

Detail Description Paragraph:
[0145] As described above, in accordance with the image processing apparatus according to this invention, it is possible to form stripe pattern in which pixel quantity is shifted in accordance with phase quantity as shown in FIGS. 13A and 13B.

Detail Description Paragraph:
[0146] On the contrary, in the conventional image processing apparatus, as shown in the Table of FIG. 17, in the operation circuits of THRU, TAKEF and GIVEB, since phase difference ph every line for taking screen angle at stripe pattern as shown in FIG. 17 is not entirely taken into consideration, control can be carried out only in one pixel units. In this respect, in the operation of this invention shown in FIG. 14, since distribution of pixel quantity is carried out in consideration of

phase quantity, it is possible to control shift operation of screen angle in units smaller than one pixel.

Detail Description Paragraph:
[0147] As a result, phase difference ph can be smaller than one pixel. Thus, smooth stripe pattern having screen angle can be formed.

Detail Description Paragraph:
[0148] As described above, in accordance with this invention, such an approach is employed to determine phase quantity every pixel value block to control value of pixel shifted to shifted pixel designated within block from respective pixels within block in dependency upon phase quantity thereof to thereby prepare dot cluster within block by pixel value shift, thereby making it possible to control position within block of dot cluster with that block by level smaller than pixel size at the time of constituting stripe pattern or texture of dots by set of dot clusters within the respective blocks. For example, in the case where cluster of dots is prepared in a manner bridging over adjacent two pixels, when a portion of one pixel is shifted to the other, i.e., shifted pixel, central position of cluster of dots is shifted (moved) to the side of shifted pixel. By controlling its shift quantity in dependency upon phase quantity, it is possible to adjust distortion of contour of the stripe pattern or unevenness of distribution of dots.

Detail Description Paragraph:
[0149] In addition, while the case where two pixels are adjacent within block as shifted pixel has been described in the above-described embodiment, pixels of which number is more than 2 can be designated as shifted pixels. By controlling shift quantity to those plural shifted pixels, it is possible to control position of dot cluster constituted on the shifted pixels with accuracy less than pixel size.

CLAIMS:

1. An image processing apparatus comprising: an intrablock pixel position judging section for judging pixel position within a block in which pixels constituting image are divided in units of plural pixels; a shifted pixel designating section for designating shifted pixel to be shifted in accordance with the pixel position judged by the intrablock pixel position judging section; a phase calculating section for determining phase quantity of intrablock dot cluster for every block; and a pixel value shift section for carrying out shift from respective pixels within the block to the shifted pixel on the basis of the phase quantity determined by the phase calculating section and, value differences of respective pixels within the block and value of the shifted pixel.

2. An image processing apparatus as set forth in claim 1, the pixel value shift section comprising a shift operation/reference position selecting section for generating a reference position signal and a shift operation select signal from coordinate of main scanning direction and coordinate of sub scanning direction within the block; and a shift operation section for carrying out shift operation from pixel data and phase quantity supplied to an operation circuit, which is selected by the shift operation select signal.

4. An image processing apparatus as set forth in claim 3, wherein the shifted pixel is two pixels or more adjacent within the block.

5. An image processing apparatus as set forth in claim 1, wherein the pixel value shift section comprises: shift quantity judging means for determining distribution of shift quantity to the shifted pixel of respective pixels within the block on the basis of the phase quantity, values of respective pixels within the block and value of the shifted pixel; and a shift operation section for shifting the shift quantity to the shifted pixel.

6. An image processing apparatus as set forth in claim 5, wherein the shift operation section serves to carry out shift operation so as to shift (move), in a distributed manner, pixel quantity of shift pixel with respect to plural different pixels in accordance with the phase quantity.

7. An image processing apparatus as set forth in claim 6, wherein distributing shift (movement) of pixel quantity of shift pixel by the shift operation section is carried out in such a manner that center of gravity position by pixels within block before shift is also maintained after shifting.

8. An image processing apparatus as set forth in claim 1, wherein the shifted pixel position judging section determines shift pixel position in such a manner that shifted pixels are linearly disposed in the main scanning direction or in the sub scanning direction.

9. An image processing apparatus as set forth in claim 1, wherein the shifted pixel position judging section determines shift pixel position in such a manner that shifted pixels are disposed in a distributed manner on line having a predetermined angle with respect to the main scanning direction or the sub scanning direction.

10. An image processing apparatus as set forth in claim 1, wherein the image processing apparatus further comprises a recording device drive signal generating section for generating a recording device drive signal on the basis of output of the pixel value shift section.

11. An image processing apparatus as set forth in claim 9, wherein the image processing apparatus serves to process color image, and the shifted pixel position judging section determines shift pixel position in such a manner that angles of line on which shifted pixels are disposed in a distributed manner are caused to be different with respect to plural images obtained by carrying out color separation of color image.

12. An image processing system comprising: an image reading unit for reading image on manuscript; and an image processing unit for processing the image which has been read at the image reading unit to output processed data, wherein the image processing unit comprises: an intrablock pixel position judging section for judging pixel position within a block in which pixels constituting image are divided in units of plural pixels; a shifted pixel designating section for designating shifted pixel to be shifted in accordance with the pixel position judged by the intrablock pixel position judging section; a phase calculating section for determining phase quantity of intrablock dot cluster for every block; and a pixel value shift section for carrying out shift from respective pixels within the block to the shifted pixel on the basis of the phase quantity determined by the phase calculating section, and value differences of respective pixels within the block and value of the shifted pixel.

13. An image processing system as set forth in claim 12, wherein the image processing unit further comprises a recording device drive signal generating section for generating a recording device drive signal on the basis of output of the pixel value shift section.